DSN Telemetry System Data Records

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The DSN Telemetry System now includes the capability to provide a complete magnetic tape record, within 24 hours of reception, of all telemetry data received from a spacecraft. This record, the Intermediate Data Record, is processed and generated almost entirely automatically, and provides a detailed accounting of any missing data.

I. Introduction

The current configuration of the DSN Telemetry System is identified as the DSN Telemetry System, Mark III-75. This system is described, and a block diagram is presented in Ref. 1. A key feature of the system is the generation of Telemetry Intermediate Data Records (IDRs). These, and other data records, are discussed in Ref. 2. This article describes in detail the capability that has been implemented in the Deep Space Network to generate the Telemetry IDRs.

II. Definitions

A. Original Data Record (ODR)

Telemetry ODRs are those records made by digital recorders at the Deep Space Station at the time of reception of data from a spacecraft. For telemetry, these records are made subsequent to bit or symbol synchronization and, where applicable, decoding. Two types of Telemetry ODRs are made:

(1) Data Decoder Assembly (DDA) ODRs are made at 64-m stations only, and normally contain high-rate data, i.e., data at rates of 2 kbps and higher.

(2) Telemetry and Command Processor (TCP) ODRs are made at all stations and contain medium- or low-rate data, i.e., data at rates of 2 kbps and lower.

Both records contain telemetry data formatted as high-speed or wideband data blocks, identical to those transmitted from the station in real time.

B. Intermediate Data Record

IDRs are digital tape records made at the Network Operations Control Center (NOCC). For telemetry data, an IDR contains all the data, time ordered by earth-received time, of a given data stream, spacecraft, and Deep Space Station (DSS). Data from different stations (during station overlaps, for example) are therefore on different IDRs. A data stream is defined as these data received on one subcarrier and one carrier from a specified spacecraft. During a pass, the bit rate may change, or the station may change the stream from one processor to another, but all such data will be on one IDR. For missions which produce multiple streams, multiple IDRs would be generated on a pass.

This record contains, as a minimum, the same data as the ODR for the same time period. The data on the IDR are in the same format as the ODR; additional records are added to provide label and summary information. The IDR is the interface for non-real-time telemetry data delivery to the flight projects. Each completed telemetry IDR and a printed summary listing are deliverable to a flight project within 24 hours after end-of-pass.

III. Functional Operation

The general configuration of data flow and data record generation are shown in Fig. 1. A more detailed description of the NOCC portion is contained in Ref. 3. The step-by-step process in generating the IDR is described in the following paragraphs.

A. Real-Time Data

In real time, all telemetry data are transmitted from the Deep Space Station to the flight project via Ground Communications Facility (GCF) high-speed and wideband data circuits. These same data are recorded at the NOCC on the Network Data Log (NDL). Experience has shown that these real-time streams have gaps caused by GCF problems and outages, by equipment malfunctions, or by loss of lock at the DSS. The subsequent steps in the IDR process are to detect these gaps and recover the data where possible.

B. Gap Lists

The telemetry equipment in the NOCC monitors each active telemetry stream and generates a list of data gaps. A gap in a stream is defined as any discontinuity in data block serial number, or any anomaly in the regular time sequence of data blocks.

Each gap consists of a pair of data block definitions: the last good block before a gap and the first good block after a gap. This block definition includes:

(1) Data type code

(2) Spacecraft number

(3) Block serial number

(4) Time tag

(5) DSS lock status code

(6) DSS configuration code

(7) Received signal strength

(8) Signal-to-noise ratio (SNR)

(9) Gap reason code

  (a) Discontinuity in block serial number

  (b) Time tag increment discontinuity

  (c) Out-of-lock condition

  (d) Change of configuration

(10) Estimate of equivalent number of data blocks in the gap

These gap lists are maintained in a computer file for use in recalling the missing data.

C. Gap List Editing

Any gap list, or selected portions thereof, can be reviewed by an analyst. Both printed outputs and cathode ray tube (CRT) displays are available. With the CRT display, the analyst can scan the list and mark any or all gaps for recall. This edited gap list is used by the recall processor to recall missing data from DSS ODRs after each pass.

D. Recall Process

The edited gap list is used to recall data automatically from the DSS ODRs. The NOCC Data Record Processor reads the gap list file, and generates the appropriate recall requests for the DSS. At the DSS, the responses are generated from the Automatic Total Recall Program (ATRS). This process is described in Ref. 4.

E. Merge Process

The final step in the IDR generation is the merging of the recalled data with the recorded (NDL) real-time data. This process is performed in the NOCC on the Data Records Processor, in an off-line non-real-time process. All inputs are via magnetic tape. The merge process generates a single IDR tape, with both real-time and recalled data arranged in proper time sequence and duplicates removed. In addition, the IDR tape contains a label record and summary records. The IDR format is shown in Fig. 2.

During the merge process, any gaps which are completely filled are deleted from the list; any unfilled gaps remain and are included in the summary record.

The IDR File Label Record contains:

(1) DSS number

(2) Pass number

(3) IDR start and stop times (approximate)

(4) Data types

(5) Spacecraft number

The IDR File Summary Record contains:

(1) DSS, pass, spacecraft number

(2) Data types

(3) IDR start and stop times (exact)

(4) Number of data blocks expected

(5) Number of data blocks written

(6) Number of data blocks missing

(7) List of all remaining data gaps

Included with each gap is a recall status code indicating either no recall tried, recall tried but not recoverable (e.g., an ODR failure), recall tried but data still defective, or a null gap with no missing data but included for information (e.g., for a bit rate change). The summary data are also listed on a printed output which accompanies each IDR tape.

IV. Performance

The Telemetry IDR function is now operational and has been used in support of the Viking Project, starting in April 1976. In routine operation, the IDRs are delivered to the project within 24 hours of the completion of each pass.

Content of the IDR consistently runs in excess of 99.9% of the expected data. This process therefore provides a timely record of the best data available on the ground for deep space missions.

References

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4. Hlavaty, F. M., "Automatic Total Recall Program for Replay of DSN 7-Track DODR's," in *The Deep Space Network Progress Report 42-25*, pp. 137–141, Jet Propulsion Laboratory, Pasadena, California, February 15, 1975.

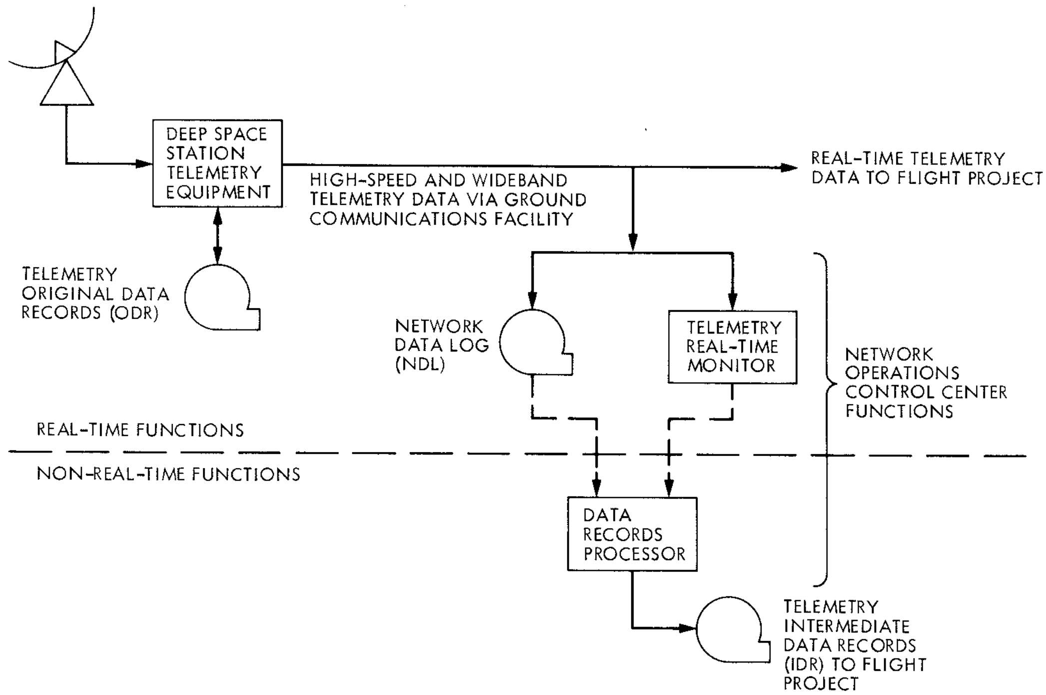

Fig. 1. DSN Telemetry System data record configuration

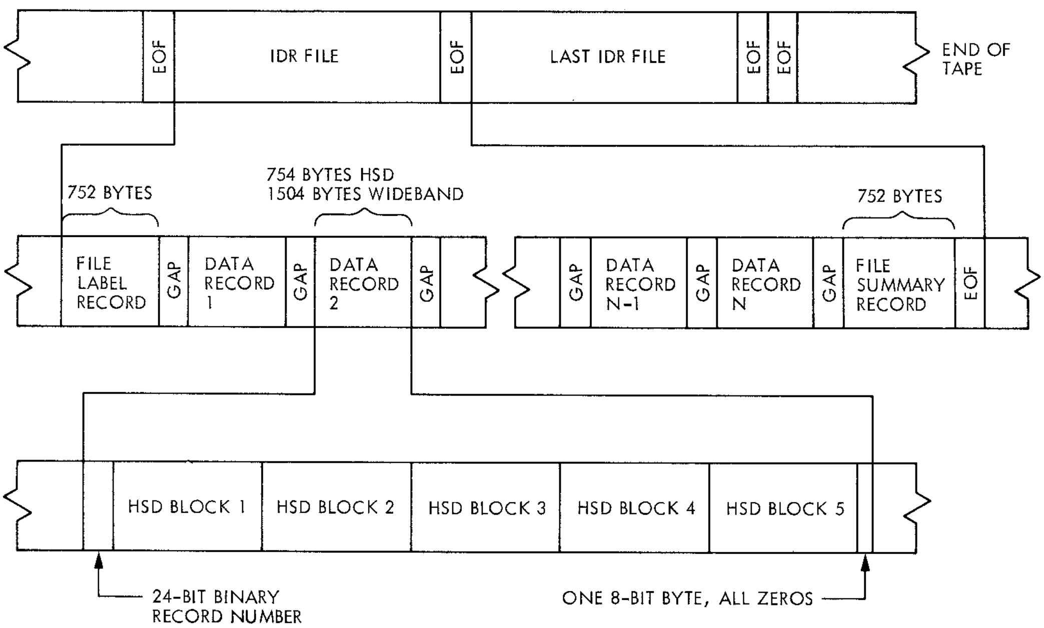

Fig. 2. Telemetry IDR format